

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/010520

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.⁷ H01S5/183

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl.⁷ H01S5/00-5/50

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

JSTPlus (JOIS)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-60739 A (Nippon Telegraph And Telephone Corp.), 06 March, 2001 (06.03.01), Par. Nos. [0018] to [0022], [0025]; Fig. 1 (Family: none)	1-10
Y	JP 11-312847 A (Nippon Telegraph And Telephone Corp.), 09 November, 1999 (09.11.99), Par. Nos. [0039] to [0040]; Fig. 2 & US 2003/0156613 A1 & US 5649553 B1 & EP 939471 A1	1, 3

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

- A- document defining the general state of the art which is not considered to be of particular relevance
- E- earlier application or patent but published on or after the international filing date
- L- document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- O- document referring to an oral disclosure, use, exhibition or other means
- P- document published prior to the international filing date but later than the priority date claimed

- T- later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- X- document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- Y- document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- &- document member of the same patent family

Date of the actual completion of the international search
01 September, 2005 (01.09.05)Date of mailing of the international search report
20 September, 2005 (20.09.05)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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Telephone No.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-164621 A (The Furukawa Electric Co., Ltd.), 07 June, 2002 (07.06.02), Par. Nos. [0023] to [0032]; Figs. 1 to 2 & <u>US 2002/0101899 A1</u> & <u>US 6700914 B2</u> & DE 10126307 A1	1, 3
Y	Tansu, N. et al., Low-Temperature Sensitive, Compressively Strained InGaAsP Active ($\lambda=0.78-0.85\mu\text{m}$) Region Diode Lasers, IEEE Photonics Technology Letters, (2000) Vol.12, No.6, pages 603 to 605	2, 4-10
Y	JP 2003-78208 A (Toshiba Corp.), 14 March, 2003 (14.03.03), Par. No. [0086] & <u>US 2003/0043875 A1</u>	7, 9
Y	JP 2000-312054 A (Sharp Corp.), 07 November, 2000 (07.11.00), Par. No. [0063] & <u>US 6541297 B2</u>	7, 9
Y	JP 2000-294877 A (NEC Corp.), 20 October, 2000 (20.10.00), Par. Nos. [0005], [0028] (Family: none)	7, 9

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See the "continuation of Box No. III" on the extra sheets.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims: it is covered by claims Nos.: 1 - 10

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

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Continuation of Box No.III of continuation of first sheet(2)

The technical matter, i.e., that the surface emitting laser diode defined in claim 1 "comprising:

a resonator region composed of a semiconductor substrate, an active layer which includes at least one quantum well layer emitting a laser beam and a barrier layer and a spacer layer which is provided near the active layer and made of at least one material and provided over a semiconductor substrate and upper and lower reflectors respectively provided over and below the resonator region over the semiconductor substrate, wherein the resonator region and the upper and lower reflectors constitute a mesa structure over the semiconductor substrate, each of the upper and lower reflectors constitutes a semiconductor distribution Bragg reflector having a periodically varying refractive index and reflecting the incident light by light wave interference, at least a part of each semiconductor distribution Bragg reflector is composed of a layer made of $\text{Al}_x\text{Ga}_{1-x}\text{As}$ ($0 < x \leq 1$) and having a small refractive index and a layer made of $\text{Al}_y\text{Ga}_{1-y}\text{As}$ ($0 \leq y < x \leq 1$) and having a large refractive index, and one of the layers constituting the resonator region contains In" is not novel since it is disclosed in document 1.

Document 1: JP 2001-60739 A (Nippon Telegraph And Telephone Corp.), 6 March, 2001 (06.03.01), [0018]-[0022], [0025], Fig. 1 (Family: none)

Therefore, the "special technical feature" of claims 1-10 is that "the lower reflector is composed of a first lower reflector having a low refractive index layer made of AlAs and a second lower reflector provided over the first lower reflector and having a low refractive index layer made of AlGaAs". (Invention 1)

The "special technical feature" of claim 11-13 is that "a part of the spacer layer is made of $(\text{Al}_a\text{Ga}_{1-a})_b\text{In}_{1-b}\text{P}$ ($0 < a \leq 1$, $0 \leq b \leq 1$), the quantum well active layer is made of $\text{Ga}_c\text{In}_{1-c}\text{P}_d\text{As}_{1-d}$ ($0 \leq c \leq 1$, $0 \leq d \leq 1$), and the barrier layer is made of $\text{Ga}_e\text{In}_{1-e}\text{P}_f\text{As}_{1-f}$ ($0 \leq e \leq 1$, $0 \leq f \leq 1$), the quantum well active layer has compression strain, and the active layer has a shape anisotropy long in the (111)A direction when viewed from the light exit direction. (Invention 2)

The "special technical feature" of claim 14 is that the step of forming a mesa structure by dry etching includes a substep of controlling the height of the mesa structure by monitoring the light emission of In". (Invention 3)

The "special technical feature" of claim 15-19 is that "a semiconductor layer containing as main components Al, In, P is formed in contact with a semiconductor layer containing as main components Al, Ga, As between the active layer and the semiconductor layer containing as main components Al, Ga, As, and the interface between the semiconductor layer containing as main components Al, Ga, As and the semiconductor layer containing as main components Al, In, P is formed in agreement with the position of the node of the electric field intensity distribution". (Invention 4)

The "special technical feature" of claim 20-22 is that "an $(\text{Al}_a\text{Ga}_{1-a})_b\text{In}_{1-b}\text{P}$ ($0 < a \leq 1$, $0 \leq b \leq 1$) layer containing as main components Al, In, P is formed in contact with a semiconductor layer containing as main components Al, Ga, As (Continued to next page)

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between the active layer and the semiconductor layer containing as main components Al, Ga, As, and Mg (magnesium) is added as a p-type dopant to the $(\text{Al}_a\text{Ga}_{1-a})_b\text{In}_{1-b}\text{P}$ ($0 < a \leq 1$, $0 \leq b \leq 1$) layer, and C (carbon) is added as a p-type dopant to the semiconductor layer containing as main components Al, Ga, As". (Invention 5)

The "special technical feature" of claim 24-27 is that "an $(\text{Al}_a\text{Ga}_{1-a})_b\text{In}_{1-b}\text{P}$ ($0 < a \leq 1$, $0 \leq b \leq 1$) layer containing as main components Al, In, P is formed in contact with a semiconductor layer containing as main components Al, Ga, As between the active layer and the semiconductor layer containing as main components Al, Ga, As, and the $(\text{Al}_a\text{Ga}_{1-a})_b\text{In}_{1-b}\text{P}$ ($0 < a \leq 1$, $0 \leq b \leq 1$) layer is a semiconductor layer having a short period superlattice structure composed of AlInP and GaInP. (Invention 6)

The "special technical feature" of claim 28-35 is that at least the low refractive index layer nearest to the active layer out of the low refractive index layers constituting the upper and/or lower reflector is made of $(\text{Al}_a\text{Ga}_{1-a})_b\text{In}_{1-b}\text{P}$ ($0 < a \leq 1$, $0 \leq b \leq 1$), and the interface between the resonator region and the low refractive index layer nearest to the active layer of the upper and/or lower reflector agrees with the node of the electrical field intensity distribution". (Invention 7)

Since there is no technical feature common to these seven inventions, and no technical relationship within the meaning of PCT Rule 13 can be seen.

Consequently, claims 1-35 does not comply with the requirement of unity of invention.